CLAIMS

1. A method for manufacturing a silicon single crystal rod which pulls a silicon single crystal rod (24) from a silicon melt (13) made molten by a heater (17), detects a change in diameter of the silicon single crystal rod (24) in the pulling process every predetermined time, and feeds back an output of the detection to a pulling speed of the silicon single crystal rod (24) and a temperature of the heater (17), thereby controlling a diameter of the silicon single crystal rod (24),

wherein a PID control in which a PID constant is changed on a plurality of stages is applied to a method which controls the pulling speed of the silicon single crystal rod (24) so that the silicon single crystal rod (24) has a target diameter and a method which controls the temperature of the heater (17) so that the silicon single crystal rod (24) has the target diameter.

2. A method for manufacturing a silicon single crystal rod which pulls a silicon single crystal rod (24) from a silicon melt (13) made molten by a heater (17), detects a change in diameter of the silicon single crystal rod (24) in the pulling process every predetermined time, and feeds back an output of the detection to a pulling speed of the silicon single crystal rod (24) and a temperature of the heater (17), thereby controlling a diameter of the silicon

single crystal rod (24),

wherein a method which directly feeds back a diameter deviation between a target diameter and a measured diameter of the silicon single crystal rod (24) to a method which subjects the pulling speed of the silicon single crystal rod (24) to a PID control so that the silicon single crystal rod (24) has the target diameter is combined with a method which feeds back a change quantity of the diameter deviation as a deviation to a current pulling speed.

3. A method for manufacturing a silicon single crystal rod which pulls a silicon single crystal rod (24) from a silicon melt (13) molten by a heater (17), detects a change in diameter of the silicon single crystal rod (24) in the pulling process every predetermined time, and feeds back an output of the detection to a pulling speed of the silicon single crystal rod (24) and a temperature of the heater (17), thereby controlling a diameter of the silicon single crystal rod (24),

wherein, when feeding back a change quantity of a diameter deviation between a target diameter and a measured diameter of the silicon single crystal rod (24) as a deviation to the pulling speed of the silicon single crystal rod (24), the pulling speed is subjected to a PID control so as not to exceed a maximum fluctuation breadth of correction with respect to a current pulling speed.

4. The method for manufacturing a silicon single crystal according to any of claims 1 to 3, wherein a quality prediction calculation for the silicon single crystal rod (24) is performed by using a pulling speed actual measurement profile from start of puling to a predetermined time and a set pulling speed from start of puling to end of puling concurrently with pulling of the silicon single crystal rod (24), and whether a defective portion is generated in the silicon single crystal rod (24) is predicted, and

when generation of the defective portion is predicted, a corrected pulling speed of the silicon single crystal rod (24) and a corrected heater temperature which are used to correct the defective portion are calculated, and the corrected pulling speed and the corrected heater temperature are fed back to the set pulling speed and the set heater temperature.

5. The method for manufacturing a silicon single crystal rod according to claim 4,

wherein the quality prediction calculation and the corrected pulling speed calculation for the silicon single crystal rod (24) are performed by a defect simulation method which maximizes a non-defective area in the silicon single crystal rod (24) by using a computer, the defect simulation method comprising:

a step of obtaining a temperature distribution in the

silicon single crystal rod (24) which grows from the silicon melt (13) while taking a convection of the silicon melt (13) into consideration under a condition for manufacturing the silicon single crystal rod (24) with a parameter P_1;

a step of predicting concentration distributions and size distributions of a void and a high-temperature oxygen precipitate in the silicon single crystal rod (24) by obtaining the temperature distribution in the silicon single crystal rod (24) in the cooling process;

a step of obtaining a difference between a maximum value of an inflection point of a first isoconcentration line and a minimum value of an inflection point of a first distribution line by a calculation after acquiring the first isoconcentration line and the first distribution line in the silicon single crystal rod (24) by a calculation;

a step of obtaining the difference between the maximum value of the inflection point of the first isoconcentration line and the minimum value of the inflection point of the first distribution line by the calculation while sequentially changing the parameter in the condition for manufacturing the silicon single crystal rod (24) from P_2 to P_N; and

a step of obtaining a condition for manufacturing the silicon single crystal rod (24) under which the difference between the maximum value of the inflection point of the first isoconcentration line and the minimum value of the

inflection point of the first distribution line becomes maximum.

6. The method for manufacturing a silicon single crystal rod according to claim 4,

wherein the quality prediction calculation and the corrected pulling speed calculation for the silicon single crystal rod (24) are performed by a defect simulation method which maximizes a non-defective area in the silicon single crystal rod (24) by using a computer, the defect simulation method comprising:

a step of obtaining a temperature distribution in the silicon single crystal rod (24) which grows from the silicon melt (13) while taking a convection of the silicon melt (13) into consideration under a condition for manufacturing the silicon single crystal rod (24) with a parameter P_1;

a step of predicting concentration distributions and size distributions of a void and a high-temperature oxygen precipitate in the silicon single crystal rod (24) by obtaining the temperature distribution in the silicon single crystal rod (24) in the cooling process;

a step of obtaining a difference between a maximum value of an inflection point of a second isoconcentration line and a minimum value of an inflection point of a second distribution line by a calculation after acquiring the second isoconcentration line and the second distribution

line in the silicon single crystal rod (24) by a calculation;

a step of obtaining the difference between the maximum value of the inflection point of the second isoconcentration line and the minimum value of the inflection point of the second distribution line by the calculation while sequentially changing the parameter in the condition for manufacturing the silicon single crystal rod (24) from P_2 to P_N; and

a step of obtaining a condition for manufacturing the silicon single crystal rod (24) under which the difference between the maximum value of the inflection point of the second isoconcentration line and the minimum value of the inflection point of the second distribution line becomes maximum.